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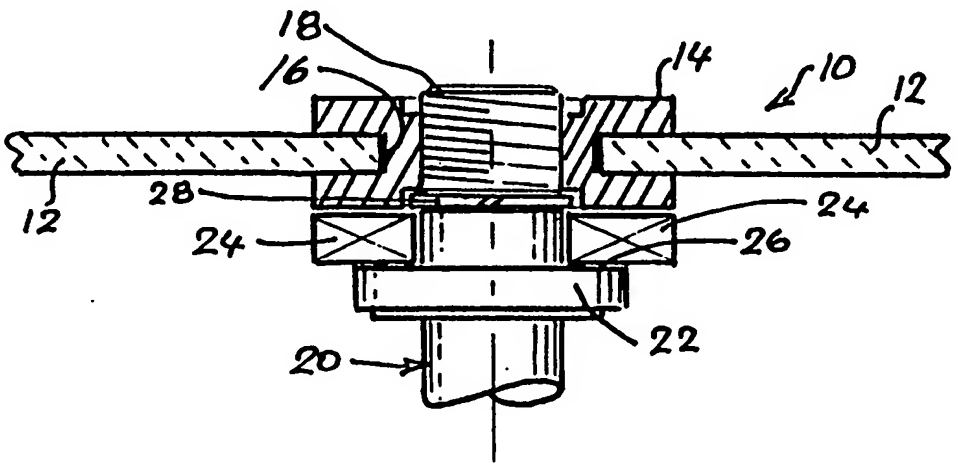

(57) Abstract

A power tool spindle and tool-element assembly is provided which allows the tool element (10) to be threadably engaged with and tightened onto the spindle stud (18), and then subsequently removed after use, without the use of tools. The tool element (10) comprises a cut-off disc or saw blade (12) fitted with a fixed internally-threaded hub (14) that engages the threaded end (18) of the spindle (20). A shoulder (22) is formed on the spindle behind the threaded stud (18) and a thrust bearing (24) is positioned between the hub (14) and the shoulder (22) so as to take the axial clamping load as the tool element (10) is tightened onto the spindle. The thrust bearing allows ready removal of the tool element even though it may self-tighten onto the spindle under spin-up or heavy loading.

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TOOL ELEMENT ATTACHMENT THREADED POWER TOOL SPINDLE

TECHNICAL FIELD

This invention relates to means for attaching blades, discs, chucks and other tool-elements to the threaded spindles of power tools. More particularly, the invention is concerned with power tool spindles for use in driving rotary tool-elements and to power tool assemblies comprising such spindles and tool elements in combination.

Since the tool element is usually attached to a free end of the power tool spindle by a nut or a bolt, the spindle-side of the tool element will be referred to as the back of or the rear and the nut or bolt side will be referred to as the front or the forward side.

BACKGROUND TO THE INVENTION

A tool element is usually attached to a power-tool spindle by a screw-threaded nut or bolt, the hand of the thread being such that the rotation of the spindle tends to tighten the nut or bolt. The result is that, when a tool element — such as a saw-blade or grinder-disc — with substantial inertia is mounted on the spindle of a powerful tool in this manner, it will slip on the spindle upon start-up and carry the nut or bolt with it causing it to tighten further by 'spin-up'. Similarly, if the tool element jams during use, the spindle will slip in the element and tend to further 'jam-tighten' the nut or bolt. The result is often that the nut or bolt is difficult to undo. To alleviate this problem, a special set of spanners is usually provided so that the nut or bolt can be tightened to minimise spin-up and jam-tightening. However, over-tightening still occurs and the nut or bolt may prove impossible to undo with the spanners provided.

In my prior PCT patent application No. PCT/AU91/00420 I disclosed a multi-part nut/bolt for use on power-tool spindles that applied its clamping pressure on the tool-element via a teflon or PTFE washer. I showed that (i) such nuts could be applied by the fingers with sufficient force to allow the spindle to drive the tool element under heavy load, (ii) such nuts would not over-tighten with spin-up and (iii) they would not jam-tighten to the point where they could not be undone with the fingers. However, there are applications were it is desirable to avoid the use of a separate nut/bolt (as well as a set of spanners). For example, where the tool element is a chuck or auger

which screws directly into (or onto) the spindle, or where a disc or saw blade is provided with a threaded hub for screwing directly onto the spindle.

US patent 5,152,106 to MacKay discloses a light-use cut-off wheel having a threaded hub for screwing onto a short shank that is adapted to be held in the chuck or collet of a small power tool. When screwed onto the threaded front end of the shank, the rear face of the cut-off wheel is tightened against a cup-like backing flange that is, in turn, supported against a shoulder on the shank. The front face of the backing flange is coated or lined with plastics material so that said material is interposed between the rim of the backing flange and the rear face of the cut-off wheel. It is said that, with the use of such dissimilar materials, the cut of wheel is easily removed from the shank without the need for tools. While this may be so in the first or second instance with small lightly-clamped cut-off discs used in fine modelling work, the plastic coating or lining on the rim of the backing-flange will be quickly scraped off or cut through after a few wheel changes. Thereafter, the problem of wheel removal would return. This design is clearly unsuited for the attachment of saw blades or grinder discs to the spindles of heavy-duty power-tools where the plastic would be cut through at the first spin-up or jam-tightening.

OBJECTIVES OF THE INVENTION

It is therefore an objective of the present invention to provide improved means for the repeated attachment and removal of tool elements to and from the spindle of a power tool, which means does not require the use of separate nuts or bolts or special tools and yet is suited to heavy-duty power tools. However, it is also desirable that the benefit of ready and easy attachment and removal of the tool elements from the spindle should be available even where a separate attachment nut or bolt is used and even where spanners or the like tools are used to secure and or remove the tool-elements.

It is also an objective of the invention to provide an improved power tool spindle for use in driving a rotary tool-element which is axially clamped by self-tightening screw-thread means against a radially disposed shoulder on the spindle.

OUTLINE OF INVENTION

This invention is based upon the realisation that, if a low-friction thrust bearing (eg, of the type disclosed in my prior application) is arranged behind the tool-element and and against the spindle shoulder, it would be possible to repeatedly replace the tool-elements of heavy-duty power-tools with ease and without the need for separate nuts and tools. Further, if the thrust bearing incorporated a solid plastic lubricant such as PTFE, it could easily be arranged so that this material is not cut or abraded by the rough surface of the tool-element. The thrust bearing may be conveniently retained on the spindle when the tool-element is removed so that it will not be lost and so that dust and grit are excluded from the bearing surfaces. Preferably, the low-friction element of the thrust bearing has an outer diameter which is comparable to that of the spindle, though it is envisaged that the bearing may include a cup-like pressure plate which acts to spread the clamping force over a larger diameter of the tool element.

From one aspect, therefore, the invention comprises a power tool spindle for driving a rotary tool-element that is axially clamped by self-tightening screw-thread means against a shoulder formed on or near the forward end of the spindle, wherein a low-friction thrust-bearing is located on the spindle forward of said shoulder for transmitting the axial clamping force applied by the screw-thread means between the tool element and the shoulder.

Where the low-friction element of the thrust bearing comprises a PTFE washer, it is also preferable that it be contained or confined against lateral extrusion or expansion. This may be simply effected, for example, by locating the washer in an annular groove formed in the spindle shoulder itself. Alternatively, the PTFE washer may be located in the annular groove of one or more cup washers. Though less preferably, roller, ball or greased-plate thrust bearings may be employed instead of a PTFE washer.

Conveniently, the distal or front end of the spindle will carry an external (male) thread adapted to engage an internally threaded nut or socket in the tool-element. If the tool element is a grinder disc or saw blade, the threaded nut will normally form

its centre or hub and be fixedly secured to the disc or blade. Alternatively, the spindle may carry the threaded socket and the tool-element may carry the threaded stud or bolt. It is also envisaged that the nut or bolt of the tool-element may be separate from the tool-element itself, as in conventional power grinders and saws.

In another form of the invention, the thrust bearing may be housed by or in the hub of the tool element and discarded with that element after its useful life has been expended. For example, a PTFE washer may be fitted to the rear face of the hub of a grinder disc so as to bear against the spindle shoulder.

Accordingly, the invention comprises power tool spindles, power tools and tool element assemblies and novel tool elements fitted with thrust bearings.

DESCRIPTION OF EXAMPLES

Having broadly portrayed the nature of the present invention, particular embodiments will now be described by way of example and illustration only. In the following description, reference will be made to the accompanying drawings in which:

Figure 1 is a sectional elevation of part of a power tool spindle fitted with a cut-off wheel or saw blade comprising the first example of this invention.

Figures 1A is an enlarged sectional elevation of one form of thrust bearing suitable for with the spindle and tool-element assembly of Figure 1.

Figure 1B is a sectional elevation of the spindle and tool-element assembly of Figure 1 showing an alternative form of thrust bearing.

Figure 2 is a sectional elevation of part of a power tool spindle fitted with a cut-off wheel or saw blade comprising the second example of this invention.

Figure 3 is a sectional elevation of part of a power tool spindle fitted with a cut-off wheel or saw blade comprising the third example of this invention.

Figure 4A is a plan view of part of the spindle and tool element assembly which comprises the fourth example of this invention.

Figure 4B is a sectional elevation of the spindle and tool assembly of Figure 4A.

Figure 5 is a sectional elevation of part of a power tool spindle fitted with a grinding disc and comprises the fifth example of this invention.

In the first example shown in Figure 1, the tool-element 10 comprises a cut-off disc or saw-blade 12 with a central hub-nut 14 bonded or swaged in a central bore 16 of the disc or blade 12. As shown, hub-nut 14 is threaded onto the threaded stub 18 of the spindle 20 of a power tool (not shown). A radial shoulder 22 is formed on spindle 20 and carries an annular thrust bearing 24 on its front face 26, bearing 24 being retained in place on spindle 20 by snap-ring 28 fitted in groove near the rear or inner end of threaded stub 18.

In operation, tool element 10 is manually threaded onto stub 18 of spindle 20 and tightened by hand (without tools) against bearing 24. When the power tool is started up, some further spin-up tightening of element 10 on stud 18 is likely to occur and, during heavy use, some further jam-tightening of hub-nut 14 on stub 18 can also be expected. This will result in some resilient extension of the stud material and some resilient compression of the hub and thrust-bearing materials, the degree of extension and compression being dependent upon the torque applied and the screw-thread friction. I have found that the thread-friction is sufficient to ensure that the tool-element 10 does not spin-off the stud upon switching-off the power-tool (due to the inertia of the tool-element) but that the tool element can be readily removed from the spindle by hand (without tools) because of the effective elimination of the hub-to-shoulder friction by use of the thrust bearing 24.

As indicated above, thrust bearing 24 can take many forms; for example, a needle or roller bearing, greased metal plates or a PTFE-washer bearing. The latter is preferred because it offers the lowest resistance to movement after a long period of

heavy static loading. Teflon or PTFE washers, however, can be extruded under heavy loads and high temperatures and it is therefore preferable (as disclosed in my prior patent applications) to, first, employ a filled or reinforced PTFE material which resists extrusion and, second, peripherally confine the PTFE washer against lateral movement. Figure 1A shows (enlarged) one form of PTFE thrust bearing 24a found to be suitable. It simply consists of a PTFE washer 30 sandwiched between upper and lower metal pressure rings 32 and 34. The inner face of each pressure ring is recessed to accommodate the washer 30 and to restrict its lateral extrusion. As shown in the drawing, the recess in each pressure ring may be of wedge-shape cross-section so that (after initial assembly and pre-loading) the pressure rings are held together by the distortion of the PTFE washer. A thrust bearing of this design is simple, cheap and effectively self-sealed against the ingress of dirt, grit and moisture.

Another form of thrust-bearing (24b) which is even simpler, but is not self-sealing, is shown in Figure 1B. Only one grooved pressure plate 36 is provided, the PTFE washer 38 being fitted within its groove so that its exposed (rear) face bears against the front or outer face of spindle shoulder 22. Of course, bearing 24b can be reversed so that the exposed face of PTFE washer 38 bears against the rear face of hub-nut 14. The other parts of the spindle 20 and the tool-element 10 are also shown and are identical to those of Figure 1, and are numbered accordingly.

In the second example, as shown in Figure 2, the tool element 40 again comprises a cut-off wheel or saw-blade 42 permanently fitted with a threaded nut-hub 44 which is again engaged with the threaded stub 46 of spindle 48. As before, a radial collar or shoulder 50 is formed on spindle 48 against which hub-nut 44 is tightened. In this example, however, instead of employing an independent or separate thrust-bearing element, the thrust bearing is formed by fitting a PTFE washer 52 into an annular recess formed in the front face of shoulder 50, the exposed front face of washer 52 being engaged by an annular ridge 54 on the rear face of hub-nut 44. Thus ridge 54, washer 52 and the shoulder groove together constitute the thrust bearing.

As the bearing of the second example is not sealed, there is the danger that grit will lodge on the exposed face of washer 52 when a disc or blade is being replaced. The life-time of the washer will therefore be limited and it will need to be replaced from time to time. Placement of the groove and washer on the hub-nut and the corresponding ridge on the spindle shoulder, thus, offers the advantage that the washer will be replaced with the disc or blade. This arrangement is shown in the example of Figure 3 where the tool-element 60 again comprises a cut-off disc or saw-blade 62 fitted with a central hub-nut 64 that engages spindle stub 68 to tighten against spindle shoulder 70. In this example, however, the inner or rear radial face of hub-nut 64 is annularly grooved to take PTFE washer 72 and the front or outer radial face of spindle shoulder 70 has an annular ridge 74 formed thereon to engage with washer 72.

The fourth example, shown in Figures 4A and 4B, employs the same thrust bearing arrangement as that of Figure 2, but a two-part hub-nut is employed to allow the hub-ridge to align itself with the shoulder groove. Referring to these Figures, tool element 80 again comprises a cut-off disc or saw-blade 82 with a hub 84 fixed in the centre thereof. The inner or rear face of hub 84 carries an annular projection/bearing face 86 which engages the front face of a PTFE washer 88 located within an annular groove 90 formed in the front face of spindle shoulder 91. Instead of internal threads, hub 84 is slotted with four equidistant grooves or slots 92 which take the corresponding external splines 94 of a threaded nut 96 that is threaded onto spindle stub 98. Nut 96 can capture hub 84 (if desired) by turning-over a lip 99 on its outer periphery, so that the nut, hub and disc or blade are purchased, used and disposed of as an assembly. Alternatively, if the nut is not formed to capture the hub, only the hub and blade/disc need be purchased as a unit and the nut may be removed, retained and reused with new blades or discs.

The use of the spline connection between the nut and the hub of the fourth example allows the bearing face 86 of hub 84 to align itself with groove 90 even where there may be slight eccentricities between the groove 90, stub 98 and nut 96. This feature reduces the danger of frictional binding between the edges of groove 90 and bearing face 86.

The fifth and final example of the invention is illustrated in Figure 5 and involves the use of a conventional grinder disc, a separate nut and a pressed steel backing plate with a thrust bearing. Referring to the Figure, the dished grinding disc 100 is secured by a nut 102 to the threaded stud 104 of spindle 106 which carries a shoulder 108 that supports a thrust bearing 110. Since nut 102 does not form a fixed hub of disc 100, disc 100 cannot be tightened onto spindle 104 by engaging the inner face of nut 102 with bearing 110. Instead, a separate, cup-like, pressed-steel backing-plate 112 is used to convey the clamping pressure applied to disc 100 by nut 102 to spindle shoulder 108 (via bearing 110). The use of such backing plates is conventional in the art.

The bearing 110 of this example may take any desired form, including any one of those indicated above. For example: a separate bearing assembly may be employed (as illustrated); a PTFE washer may be located on the outer face of shoulder 108 (within a recess if desired) and the inner rear face of backing plate 112 may be engaged directly with the washer; or, the said face of backing plate 112 may be coated with PTFE, or recessed to take a PTFE washer. In either of the latter cases, the backing plate can be retained on the spindle (as part of the bearing) by the use of a snap-ring (as indicated above) or it may be separable and replaceable.

It will be appreciated that the examples described above allow the attachment and removal of a tool-element to and from a power-tool spindle without the need for tools and, if desired, without the need for a separate nut or bolt. It will also be appreciated the mention of PTFE as the material of the solid-lubricant or low-friction means is purely indicative. Other solid lubricant materials - including ceramics such as zirconia - may be employed and, though less desirable, ball or roller bearings may be used as the thrust bearing. Many other variations and additions to the examples provided without departing from the principles of the present invention.

It is also important to note that this invention embraces power tools and their rotary tool-elements modified and improved as indicated, the power tools and tool-elements indicated being used or sold in combination or as independent products.

CLAIMS:

1 A power tool spindle for use in driving a rotary tool-element that is axially clamped by screw-thread means against a radially-disposed shoulder formed on or near one end (herein called the front end) of the spindle, wherein a low-friction thrust-bearing is located against the spindle shoulder for transmitting the axial clamping force applied by the screw-thread means to a tool-element.

2 A spindle according to claim 1 wherein retaining means are provided on or in association with the spindle for effecting the retention of the thrust-bearing in place on the spindle when no tool element is attached to the spindle.

3 A spindle according to claim 1 or claim 2 wherein the thrust-bearing comprises a low-friction plastics washer or other solid low-friction material.

4 A spindle according to claim 3 wherein said washer is located within an annular groove formed within the front face of the shoulder and/or in the rear face of the hub of the tool-element so that outward radial extrusion of the washer material under load is restricted by the outer circumferential wall of said groove.

5 A spindle according to claim 1, 2 or 3 wherein the thrust bearing comprises:

- an annular metal pressure plate having an annular groove formed in one face thereof, and
- a low-friction plastics washer located within said annular groove of the pressure plate so that radial extrusion of the washer material under load is restricted by the outer circumferential wall of the groove.

6 A spindle according to any preceding claim including a cup-shape backing plate having an outer radially-disposed front face for engaging the rear surface of a disc-like tool-element, and an inner radially disposed rear face for engaging said thrust bearing.

7 A power tool and tool-element assembly including a tool-element attached to a spindle as claimed in any preceding claim.

8 A power-tool spindle substantially as herein before described with reference to any one of the accompanying drawings.

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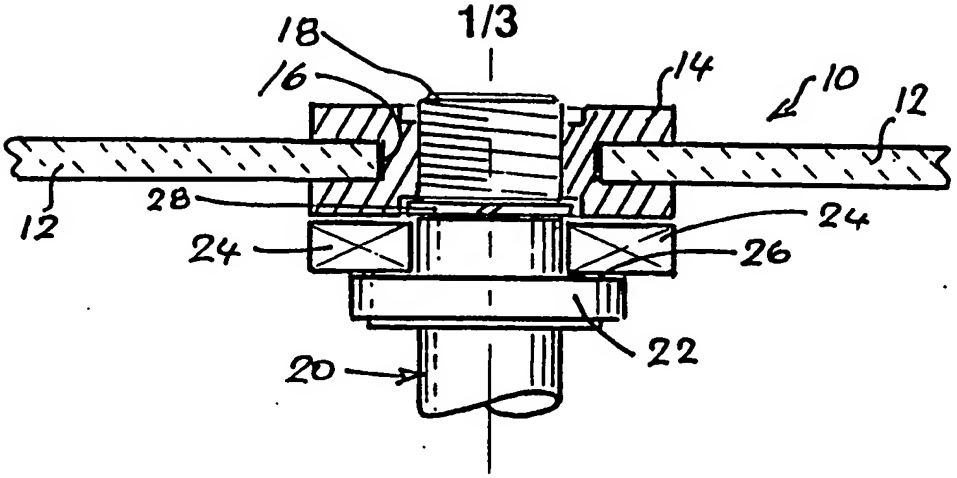

FIGURE 1

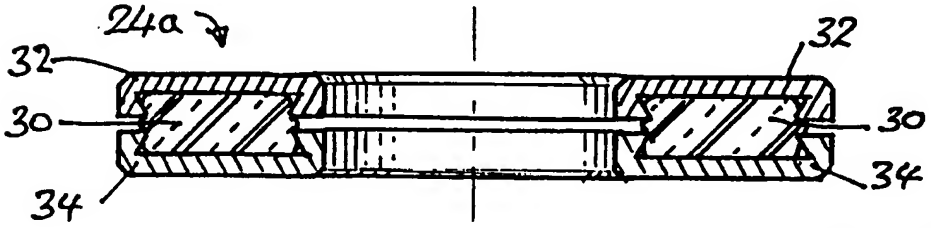

FIGURE 1A

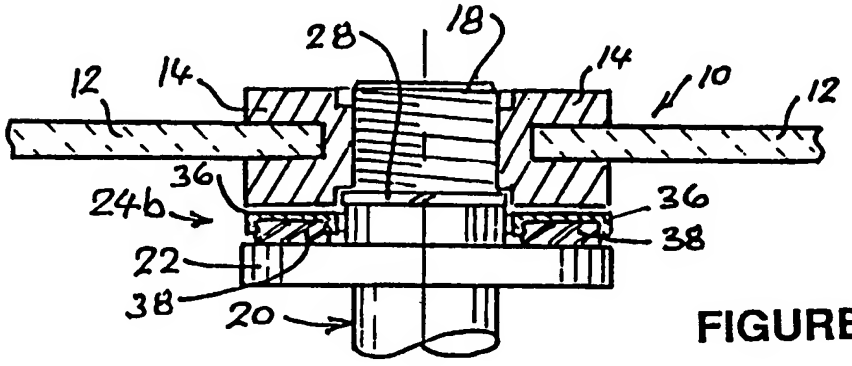

FIGURE 1B

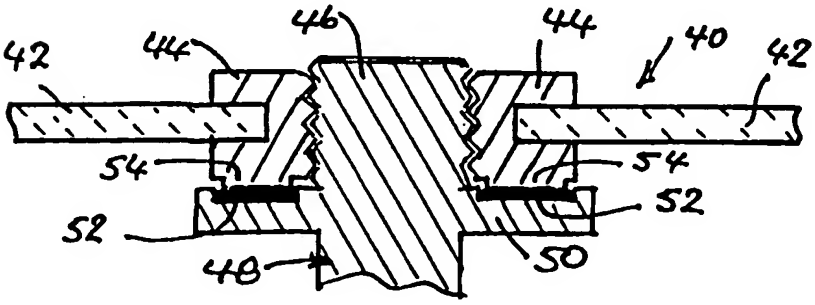

FIGURE 2

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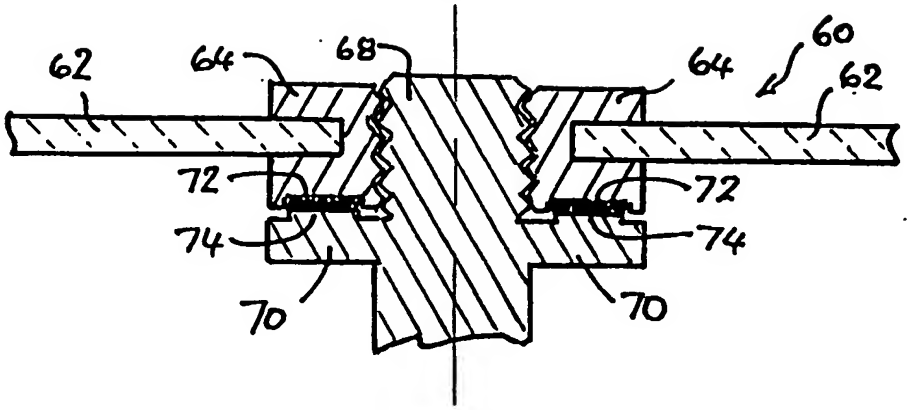

FIGURE 3

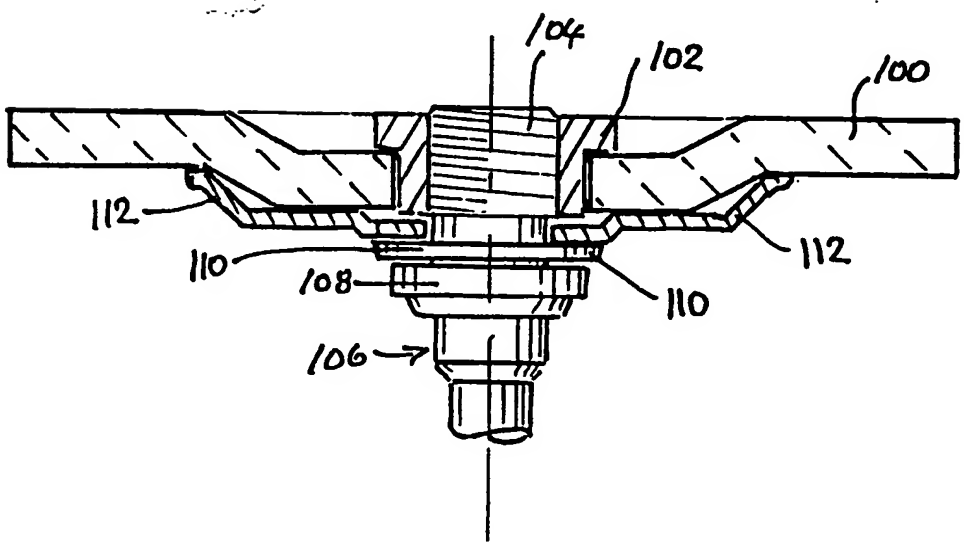

FIGURE 5

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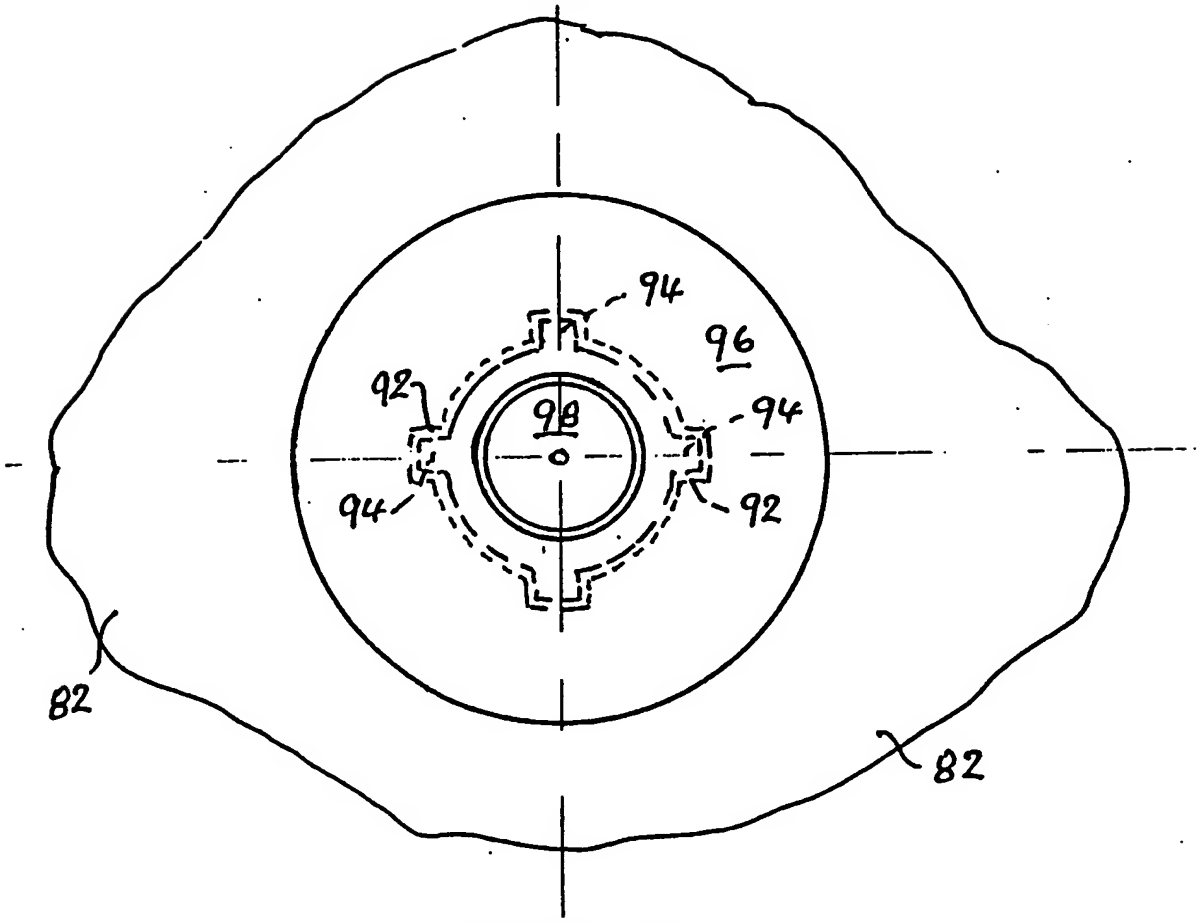

FIGURE 4A

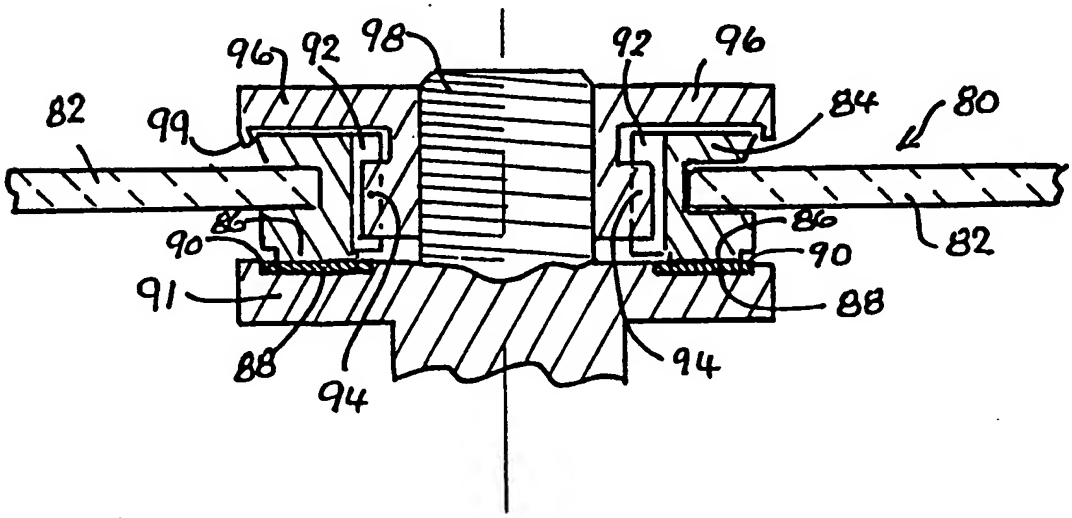

FIGURE 4B

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A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] B23Q 3/12, B27B 5/32

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	WO,A, 92/04549 (MATTHEWS) 19 March 1992 (19.03.92) page 12 lines 6-11 figure 6	1
A	EP,A, 558277 (BLACK & DECKER INC) 1 September 1993 (01.09.93) abstract figure 1	
A	EP,A, 588483 (NAKAMURA) 23 March 1994 (23.03.94) abstract figure 7	
A	GB,A, 2252061 (BOSCH GmbH) 29 July 1992 (29.07.92) abstract figure 1	

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[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 September 1994 (20.09.94)	5 OCTOBER 1994 (05.10.94)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer D.G. FRY Telephone No. (06) 2832130

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
A	DE,A, 2302033 (JOHANSON) 25 July 1974 (25.07.74) figure 5	
A	DE,A, 3942806 (WALDNER) 27 June 1991 (27.06.91) abstract figure 1	
A	CH,A, 515778 (SOCIETE GENEVOISE D'INSTRUMENTS DE PHYSIQUE) 14 January 1972 (14.01.72)	
A	AT,B, 396888 (FURLINGER) 27 December 1993 (27.12.93) abstract figure 1	
A	US,A, 5152106 (MACKAY) 6 October 1992 (06.10.92) abstract figure 1	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member					
WO 9204549	AU	85296/91	BR	9106833	CA	2092701
	EP	548169	FI	931084	HU	9300714
	NO	930899	ZA	9107288		
EP 558277	GB	9204345				
EP 588483	CA	2092018	JP	6081823		
GB 2252061	DE	4102420				
CH 515778	DE	2150558	GB	1343214		
AT 396888	IT	9022284	ES	2027151	FR	2655666
	DE	4039508				
US 5152106	AU	73014/87	CA	1305860	CN	87102592
	EP	318476	WO	8705847		
						END OF ANNEX